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ABSTRACT

A field study was conducted on the relationships between use of an information system, as a primary criterion for system success, and three secondary criteria--profitability, contribution to user performance, and user satisfaction.

The information system which served as a vehicle for the study was an implementation of the Project Evaluation and Review Technique (PERT) in a large research and development organization. Project managers in the organization, and their assistants, constituted the population of potential users.

The data suggest that use is highly dependent on the contribution of the system to user performance. Degree of use, therefore, is a convenient surrogate for the less easily measured concept of system success.

INTRODUCTION

The level of use has been posited as a major criterion for the success of an information system. It has also been suggested that use is encouraged when a number of secondary criteria are attained, and depressed when they are not. The transitory nature of such use has also been noted, with systems considered successful during some period of their existence and then falling into disuse. Given the close relationship between use and success, it is clear that an understanding of the reasons for use and disuse would contribute to the ability to construct successful systems, hence the importance of research in this area (Ein-Dor & Segev, 1981; Garrity, 1963; Swanson, 1974).

Lucas (1975) postulated that use of an information sysem, U, is given by:

$$U = f(P, S, I, D, A)$$

where P = performance,
S = situational factors,
I = personal factors,
D = decision style, and
A = attitudes and perceptions,

and where performance, P, is given by

$$P = f(S, I, D, U)$$

with variables defined as above. Thus, this is a feedback model in which use affects performance, and performance affects use.

An empirical study was conducted to test this model. Based on his findings, Lucas

raised a question which motivated the present study:

> "Given the weak associations between performance and the use of the system, are heavy investments in information systems justified?"

The study reported in this paper replicates Lucas' finding of weak associations between performance and system use, but also provides a partial answer to his question, as noted in the Discussion section.

Two additional studies of the use of information systems suggest that familiarity with such systems tends to breed indifference (Koester & Luthans, 1979; Luthans & Koester, 1976). In their two experiments, Koester and Luthans showed that people with previous computer experience tend to put information systems down, while people with no experience are influenced by them. Specifically, in their case, computer experienced subjects were affected more by mimeographed data than by computer output; the opposite was observed in naive subjects.

Measures other than use have been posited as criteria for information system success. These include:

- profitability (Carlson, 1967; Garrity, 1963),
- quality of decisions or level of performance (Carlson, 1967; Lucas, 1975),
- user satisfaction (Powers & Dickson, 1973), and
- application to major problems of the organization (Garrity, 1963).

In previous work, the authors have posited a relationship between these criteria and use (Ein-Dor & Segev, 1981). Their assumption is that widespread use will be attained only if at least some of the other criteria are satisfied. Thus, use is considered the primary success criterion while the additional criteria noted above are secondary criteria of success which become operative through their effect on use. This paper reports on a field study of the relationships between use of an information system, as the primary criterion, and the other, secondary, criteria.

PROPOSITIONS

Profitability is generally regarded as a major goal of MIS, but one that is very difficult to attain. Not only is profitability not easy to attain, but its definition and evaluation are also not trivial matters. This is a result of the fact that the impact of information systems on profits is not necessarily direct or tangible; information systems frequently achieve their benefits indirectly, via improved service or improved decision making, rather than by direct cost savings or revenue enhancement. Thus, the concept of "profitability" may range all the way from directly measurable impact on the profit and loss statement to subjective intuitions that system benefits outweigh costs. Furthermore, the existence and magnitude of intangible benefits cause difficulties in that they render inadequate, widely used cost-benefit, or rate-of-return criteria (Coe, 1974; Diebold, 1969; Garrity, 1963; Head, 1970; Knutsen & Nolan, 1974; McKinsey Quarterly, 1968; Nolan, 1973; Schwartz, 1969; Singer, 1969).

Given the wide range of possible interpretations of "profitability," it would be useful if the concept were carefully defined when used in the context of information systems. Unfortunately, this is not generally the case. Some of the earliest studies in the field of information systems were directed at the problem of information system profitability, without explicitly defining

the concept, but relying on an intuitive understanding of it. A lack of cost-effectiveness was noted as a cause of the development of systems, the cost of which was not justified. One study of 150 of the 500 largest corporations found that only one third of their computer operations were "profitable." At about the same time, excessive costs were cited as a reason for lack of advanced use of information systems in hospitals (Coe, 1974; Emery, 1973; Garrity, 1963; Gupta, 1974; Hansen, 1975; Kronenberg, 1967; Lucas, 1973; McKinsey Quarterly, 1968; Nolan & Knutsen, 1974; Schwartz, 1969).

In this study, three measures of profitability of the information system were employed; one was objectively documented data on actual costs relative to budget. The other two measures of profitability were subjective evaluations of relative resource requirements and cost savings.

> Proposition 1. The use of an information system will increase when it is perceived as profitable and will decrease when it is perceived not to be profitable.

A prevalent opinion implies that a good system, in itself, will provide motivation for use; users will be working with better data in more useful forms and this will improve their performance and increase their confidence. But, since using better systems seems to require more effort of users, and also seems to raise their anxiety levels, it is not at all clear that greater use will actually result. This may explain a number of surveys which found low motivation on the part of managers to use information systems (Grindlay & Cummer, 1973; Guthrie, 1974).

The relationship between performance when using a system, and use of the system, has not been studied intensively. It is clear, however, that the relationship is not a simple one. The evidence currently available seems to indicate that subjects may prefer one system over another without this having any significant effect on their performance. It may transpire that, within fairly broad ranges, the main effect of changes in system characteristics is to change user motivation to use a system rather than to improve performance (Benbasat & Schroeder, 1977; Chervany & Dickson, 1974; Cohen & Van Horn, 1972; Cosier, Ruble, Aplin, 1978; Dickson, Senn, Chervany, 1977; Mitroff, Nelson, Mason, 1974; Schroeder & Benbasat, 1975).

Probably the best known work in the field is that produced by the research program known as the Minnesota Experiments (Dickson, Senn, Chervany, 1975). The thrust of these studies was on the effects of system characteristics (degree of aggregation, method of presentation, availability of decision aids, and report availability) on a number of performance measures, which included use of the system and decision quality. These experiments did not attempt to relate decision quality to use directly, but, in three cases, the relationship of both these variables to system characteristics was observed. The results are summarized in Table 1. Although these studies tell us little about the relationship between performance and use, they do seem to hint that both are affected by, or are indifferent to, the same system characteristics, indicating that they may be correlated between themselves.

> Proposition 2: The greater the contribution to improved decisions or performance, the greater the use of an information system, and the smaller the contribution, the lower the level of use.

In addition to the objective factors posited in the first two propositions as encouraging use, the subjective evaluations of users, as measured by user satisfaction, must also be considered as affecting the use of infor-

Table 1. Relationships Between System Characteristics and Measures of Performance

Independent variables: system characteristics	Study	Dependent variables: performance measures	
		use of system	decision quality
degree of aggregation	Senn & Dickson (1974)	-	-
method of presentation	Senn & Dickson (1974)	+	+
	Benbasat & Schroeder (1977)	+	+

+ = strong relationship

- = weak relationship

mation systems. The strongest concrete evidence in this direction is provided by Robey and Zeller (1978). Their study focused on the implementation of the same system in two similar departments of a very large corporation. The system was adopted and used extensively by one of the departments, but was rejected and discontinued by the second department after six months. Two significant differences were found between the attitudes of the adopting and rejecting users; the adopting group viewed more favorably (1) the effect of the system on their performance, and (2) the urgency and importance of the system to the organization. The effect of the system on performance is as subjectively evaluated by users, and may or may not fit the reality.

Proposition 3: The better users are satisfied with it, the greater will be the use of an information system, and the less their satisfaction, the lower the level of use.

An important factor regarding information systems is the extent to which they address the major problems or key tasks confronting the organization; this is considered to contribute critically to the success of MIS. However, system developers are sometimes advised to be opportunistic, to implement with minimum delay, and to score early victories. Such advice can lead them into the trap of attacking trivial problems in their desire to exhibit working systems as early as possible (Argyris, 1971; Coe, 1974; Colton, 1972-73; Garrity, 1963; Gupta, 1974; McFarlan, 1971; McKinsey Quarterly, 1968; Nolan, 1973; Nolan & Knutsen, 1974; Robey & Zeller, 1978; Schaffir, 1974; Zani, 1970).

Proposition 4: The use of an information system will increase when it is perceived as attacking a major problem of the organization, and will decrease if the problem is not perceived to be of great importance.

In many cases, profitable systems are those which attack major organizational problems. This, however, is not always necessarily so. Systems may be profitable, but solve only minor problems; for example, an employee leave record system may reduce clerical costs, thus contributing to profit, but would rarely be considered of great significance. On the other hand, a system might assist with a problem of extreme importance to the organization--cash flow forecasting for example--but be more expensive than a manual alternative.

The study reported here related to only one system and could not collect data which would differentiate the use of systems applied to major problems of the organization from those which attacked minor problems. Proposition 4, therefore, was not treated empirically. However, as the subject of the study was a research and development organization, and as PERT is a tool for managing projects such as those which are the raison d'etre of the organization, there can be no doubt that the system addressed a major problem. The observed behavior of participants in the study, as described below, confirms this.

METHODOLOGY

This study of the relationships between the use of a management information system and the secondary criteria for the success of such systems was conducted in a large research and development organization. The information system itself was an implementation of the Project Evaluation and Review Technique (PERT). The pool of potential users comprised the project management personnel in the organization. A PERT system had been in operation for about six years at the time of the study. When the system was first introduced into the organization, it aroused considerable interest. As a result, a number of seminars and workshops were held for potential users at all levels of management and for information system personnel.

Following installation of the PERT system, use rose slowly from zero to its highest level. Then, for about a year, the level of use stabilized, followed by a rapid and dramatic decrease in use to the point where it became doubtful whether the system should continue to be maintained. Of the twenty-four managers questioned, eighteen had used PERT and six had not; of the eighteen who had used the system, only two continued to do so at the time of the study. It was this change in the level of use which made the particular organization studied an attractive subject. It was assumed that more information could be obtained from a case in which such changes were observed than in an organization in which use was a constant. Furthermore, the fact that the system was adopted enthusiastically at first precludes the possibility of irrational resistance as the reason for lack of use. This must, therefore, be the result of some basic incompatibility between the system and its users.

Data were collected from the organization's files and by means of a questionnaire. Files on seventy projects completed by the organization provided data on project duration and success, in terms of conformance to budget and schedule. Convenience was the criterion for choice of files in this sample, so that the choice was random with respect to substantive content.

Two kinds of use were measured in the study. One is use of PERT in the past, as verified by the project files. Of the seventy files selected, it transpired that in

seventeen of the projects PERT had been employed as a control device; in the remaining fifty-three projects, the PERT system had not been used. The second kind of use, intended use in the future, was obtained from responses to Question 1 on the Questionnaire:

1. Do you think that you will use PERT again in the future? (yes/no)

The questionnaire was submitted to a sample of twenty-four managers--sixteen project managers, three department heads, and five aides responsible for monitoring progress on projects. Of the twenty-four questioned, twenty-two knew what PERT was and were aware of its availability. Two did not know of its existence. Of the twenty-two who knew about the system, eighteen had used it at some time, sixteen had used it three times or less and then stopped using it, while only two had used it more than three times. Only those managers who had used PERT in the past were asked about intended future use.

Operationalization of the independent variables in the three propositions tested, and the sources of data, were as follows:

Proposition 1--profitability. The profitability of the system, as perceived by the users, was evaluated by two questions on the test instrument. One related to savings realized on the projects from use of the system, and the other related to resources required for using PERT. The questions were:

2. Rate the level of resources required to operate PERT relative to total investment in the projects in which it was used. (very high/high/medium/low/very low)

3. Did the use of PERT save resources in projects in which it was used? (yes/no)

Proposition 2--contribution to quality of decisions and performance. Both objective and subjective data were available for the evaluations of this proposition. Project files provided objective data on the conformance of projects to schedule and to budget, the major criteria of project success. Note that success and failure are treated here as dichotomous--if the project conformed to budget it was a success in terms of the budget criterion, otherwise, a failure; the same is true of the schedule criterion. Clearly, minor deviations from budget or schedule should not disqualify a project from being considered a success, and it is necessary to establish acceptable deviations. In practice, this issue did not arise, and projects which failed were obviously in that category. A subjective evaluation of the extent to which users changed decisions as a result of the availability of PERT was provided by a question on the test instrument:

4. Did the use of PERT ever lead to a change in a decision or to a new decision? (yes/no)

Proposition 3--user satisfaction. A number of questions were directed at evaluating this variable. These included ratings of difficulties encountered, the quality of information provided, readiness to use the system again, and degree of goal attainment. The specific questions were as follows:

5. Did the system operator encounter technical difficulties in operating it? (yes/no)

6. If yes, rate the level of difficulties. (very great/great/medium/low/very low)

7. Did the system operator encounter logistic difficulties? (yes/no)

8. If yes, rate the level of difficulties. (very great/great/medium/low/very low)

9. Were there other problems not related directly to the PERT system (key punch errors, machine errors, etc.)? (yes/no)

10. If yes, rate the level of difficulties. (very great/great/medium/low/very low)

11. Is the mode of presentation of data in PERT preferable to manual presentation? (yes/no)

12. To what extent were your goals in using PERT realized? (completely/to large extent/to some extent/to small extent/not at all)

RESULTS

The two questions related to system profitability, Proposition 1, referred to resources required by the system and to savings. The data on resource requirements are exhibited in Table 2a. Five of the respondents who had used PERT considered the investment very low compared to that in the projects themselves, five considered it low, and eight considered it medium--none thought the cost was high or very high. Thus, the general feeling of users was that the system was not excessively expensive. Nevertheless, users were differentiated in their willingness to use the system by their evaluation of its cost. Thus, those who perceive the resource requirements to be very low were nearly unanimous in their willingness to use it again. As the perceived cost increased, the tendency to use the system again declined, and the number of those uncertain as to whether they would use it again increased. Following Morrison[1] we assume that those who are uncertain will not, in fact, use the system again, and if we classify together those who consider the cost low or medium, the distribution of intended use with respect to perceived cost is as in Table 2b. Using Fisher's exact probability test (Brownlee, 1965), the hypothesis that intended use is dependent on perceived cost is then significant at the .1 level.

Of the eighteen managers questioned, only two thought that any savings had been achieved by using PERT, while sixteen believed that none had (Question 3). This would render the system unattractive in spite of the general perception that it is relatively inexpensive. Thus, users do not seem to perceive of the system as profitable, and this may well be one cause of the observed decline in its use, an argument supported by the data in Table 2 and strengthening Proposition 1.

For the evaluation of Proposition 2, data were obtained from project files on conformance to budget and schedule. The results are exhibited in Table 3. The data for all projects (Table 3a) revealed no significant relationship between use of PERT and project success. It was considered that PERT might be more useful on long projects than on short ones, so the data were partitioned into those projects of one year's duration, or less (Table 3b), and those of more than one year's duration (Table 3c). Although the data for the longer projects exhibit a somewhat closer relationship between use of PERT and project success, in no case does the relationship approach statistical significance. Surprising as these findings are, given the reputation enjoyed by PERT, they certainly strengthen Proposition 2, and so help to explain the decrease in

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[1] Morrison (1979) found that potential purchasers of a product, in our case potential users, who when surveyed did not know whether they would purchase, eventually did not.

Table 2. Relationship Between Intended Future Use of PERT and Perceived Resource Requirements

Resource Requirements	Intended Future Use			
	Will Use	Will Not Use	Do Not Know	Total
a. Detailed Data				
1. Very Low	4	-	1	5
2, Low	2	1	2	5
3. Medium	2	3	3	8
4. High	-	-	-	-
5. Very High	-	-	-	-
Total	8	4	6	18
b. Contracted Form*				
1. Very Low	4	1	-	5
2. More Than Very Low	4	9	-	13
Total	8	10	-	18

*For Fisher's Exact Probability Test, p = 0.088.

Table 3. Success and Failure of Projects Contingent on Use of PERT

	Success	Failure	Total	Statistics
a. All Projects:				
Budget Criterion				
PERT Used	7	10	17	$chi^2 = 1.53$
PERT Not Used	33	20	53	$p < .3$
Total	40	30	70	
Schedule Criterion				
PERT Used	11	6	17	$chi^2 = 1.53$
PERT Not Used	29	24	53	$p = .5$
Total	40	30	70	
b. Projects of One Year Duration of Less:				
Budget Criterion				
PERT Used	4	4	8	
PERT Not Used	25	14	39	$p = .79$*
Total	29	18	47	
Schedule Criterion				
PERT Used	5	3	8	
PERT Not Used	25	14	39	$p = .72$*
Total	30	17	47	
c. Projects of More Than One Year Duration:				
Budget Criterion				
PERT Used	3	6	9	
PERT Not Used	8	6	14	$p = .49$*
Total	11	12	23	
Schedule Criterion				
PERT Used	6	3	9	
PERT Not Used	4	10	14	$p = .17$*
Total	10	13	23	

*Normal approximation, for large samples, to Fisher's exact probability test (Brownlee, 1965).

willingness to use the system in this organization.

Further support for Proposition 2 is provided by Question 4 in the questionnaire, on the effect of PERT on decisions. Of the eighteen respondents who had used the system, only ten reported changing or initiating decisions as a result, hardly an overwhelming endorsement. Thus, lack of contribution to decision effectiveness, together with lack of contribution to project success would certainly seem to help explain the lack of enthusiasm among experienced users.

The evidence relating to Proposition 3 is exhibited in Table 4. On item (a), the quality of data presentation, nine users thought that PERT was preferable, but nine did not; again, a less than enthusiastic appraisal of the attractiveness of the system. The same is true of item (b), the extent of goal attainment. Only one respondent rated this item as better than medium--the mean score being 2.6 on a five point scale with an expected value of 3. The mean scores of item (c) of Table 4 are uniformly low, indicating that users did not experience significant difficulties in using the system. This could not, therefore, be a cause of dissatisfaction, and does not strengthen Proposition 3. It does, however, indicate that the reasons for user rejection of the system are performance oriented rather than technical in nature.

A more detailed analysis contained in Table 5 exhibits the effect of degree of goal attainment on willingness to use the system in the future. Following Morrison (1979) as in Table 2, those who do not know whether they will use PERT again may be combined with those who are sure they will not. Then, partitioning the sample between those who rated goal attainment low to nil, and those who rated it medium or better, the distribution of intended use with respect to goal attainment is as in Table 5b. Applying Fisher's Exact Proba-

Table 4. Measures of User Satisfaction

		Yes	No
a.	Data Presentation Better Than Manual Reports	9	9

		Nil (1)	Low (2)	Medium (3)	High (4)	Perfect (5)	Mean Score
b.	Extent to Which Your Goals Were Attained	1	6	10	1	-	2.6

c.	Level of Difficulty	Very Low or Nil (1)	Low (2)	Medium (3)	High (4)	Very High (5)	Mean Score
	Technical	24	-	2	2	-	1.6
	Logistic	10	-	1	7	-	2.3
	Other	10	2	6	-	-	1.8

Table 5. Relationship Between Intended Future Use of PERT and Perceived Effectiveness

Goal Attainment	Intended Future Use			
	Will Use	Will Not	Do Not Know	Total
a. Detailed Data				
1. Not At All	-	1	-	1
2. To Little Extent	1	2	3	6
3. To Some Extent	6	1	3	10
4. To Large Extent	1	-	-	1
5. Completely	-	-	-	-
Total	8	4	6	18
b. Contracted Form				
1. Very Low	1	6	-	7
2. More Than Very Low	7	4	-	11
Total	8	10	-	18

*For Fischer's Exact Probability Test, $p < .056$.

bility Test, the hypothesis that intended use is related to satisfaction, as measured by degree of goal attainment, is significant at the 0.1 level. The decline in use of PERT does seem to be associated with user dissatisfaction, thus strengthening Proposition 3.

DISCUSSION

In the organization studied, there was no prior opposition to the PERT system; evidence of this is the initial enthusiasm which accompanied its installation and considerable use which followed. Nor, as the data show, can the discontinuation of use be attributed to excessive resource requirements or to difficulties in using the system.

An explanation of the disuse into which the system fell is provided by the perception of users that their level of goal attainment with the system was less than satisfactory, and by the clear indication that this perception depressed willingness to use the system again. Furthermore, the subjective evaluation of mediocre performance is substantiated by the objective data which

show that the system was, in fact, of little use in improving the success of projects to which it was applied.

This is consistent with Lucas' (1975) finding, reported in the Introduction section, that use was not strongly associated with improved performance. The current study leads to the hypothesis that when it does not improve performance, use also declines over time. One might further hypothesize that contribution to performance is the most important determinant of use, and therefore success, of information systems, outweighing both profitability and user satisfaction. Verification of these hypotheses requires the collection of data from many systems distributed among sixteen cases representing all combinations of at least two states of contribution to performance, profitability, and user satisfaction, correlated with use or its absence. Such an extensive study should provide considerable insight into the motivation to use information systems.

The question will inevitably be raised whether the organization studied is sui generis or is representative of a larger population so that the findings can be generalized. It may well be that the organization studied was unusual in its inability to utilize PERT successfully, as many other organizations have done. But abstracting from PERT in particular, and regarding it as representative of management information systems in general, is an example of an information system which was ineffective in terms of user and organizational performance in a specific context. The data strongly suggest that it was the lack of contribution to performance which led to disuse; this finding is generalizable to any information system in any organization in which its contribution is disappointing.

At an even higher level of abstraction, this study raises the same question as did Lucas about the efficacy of information systems. As noted above, Koester and Luthans (1976 & 1979) found that experienced users of computerized information systems are less impressed with them than are naive users. The same seems to be true of this study; as users became more familiar with the system so did enthusiasm and use decline. This leads the authors to hypothesize that these studies may contain some explanation of a widespread phenomenon, frequently mentioned in the literature, in which a system is initially successful and then later falls into disuse. There would seem to be a real need to study what it is that causes an information system, such as PERT, to be ineffective and to generate indifference in one organization, at the same time that it is considered a great and continuous success in others.

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